de ROALDES (A.W.)

AN IMPROVED

MOTOR-DYNAMO AND ELECTRICAL CABINET.

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presented by the author

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AN IMPROVED MOTOR-DYNAMO AND ELECTRICAL CABINET.*

With a view of facilitating the application of electricity for medical and surgical purposes, and, at the same time, economizing in the cost of using this agent, I have had constructed an improved electrical cabinet, for which I claim, after one year's daily use, the following advantages: Reliability in its action, precision in its application, convenience in the varied uses for which it may be adapted, and economy in the motive power.†

Although primarily constructed for my needs in the treatment and investigation of diseases of the ear, nose and throat, it may, without any change in its mechanism, be adapted to all the present requirements for which electricity is used in medicine and surgery.

The cabinet (Fig. 1) contains arrangements for generating the current required for heating electro-cauteries of all sizes, for operating the drill motor, for lighting up small lamps of all kinds, for applying the various forms of induced currents and the galvanic current. In the application of each of these methods there are new and special features which render the cabinet of more than ordinary importance.

The cabinet very much facilitates the use of the electro-cautery. Instead of using the *direct* current, as is almost universally the case, an alternating current of low tension is used, as will be explained later, which adds considerably to the life of the cautery point. By means of the rheostat *M* (Fig. 2) the current may be regulated for cauteries of all sizes, and the heating and cooling of the cautery points are regulated by pressure on the footpiece.

The drill apparatus also has special features which make it valuable to the surgeon. The capacity of the motor being one-quarter horse-power, will give sufficient power for operating in all kinds of surgical work for which the drill and trephine are adapted, and the working of the motor may be so adjusted that a speed of from 1500 to 6000 revolutions per minute may be attained. Of especial value is the power of the footpiece to control the operations of the drill, as, by

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*Read before the first Pan-American Medical Congress held in Washington September, 1893.

†I avail myself of the opportunity to publicly thank Messrs. Buchel Brothers, electrical engineers (101 and 103 Conti street, New Orleans), who, in the construction of my Motor-Dynamo, have displayed the highest mechanical skill, coupled with an uncommon technical knowledge of electricity.

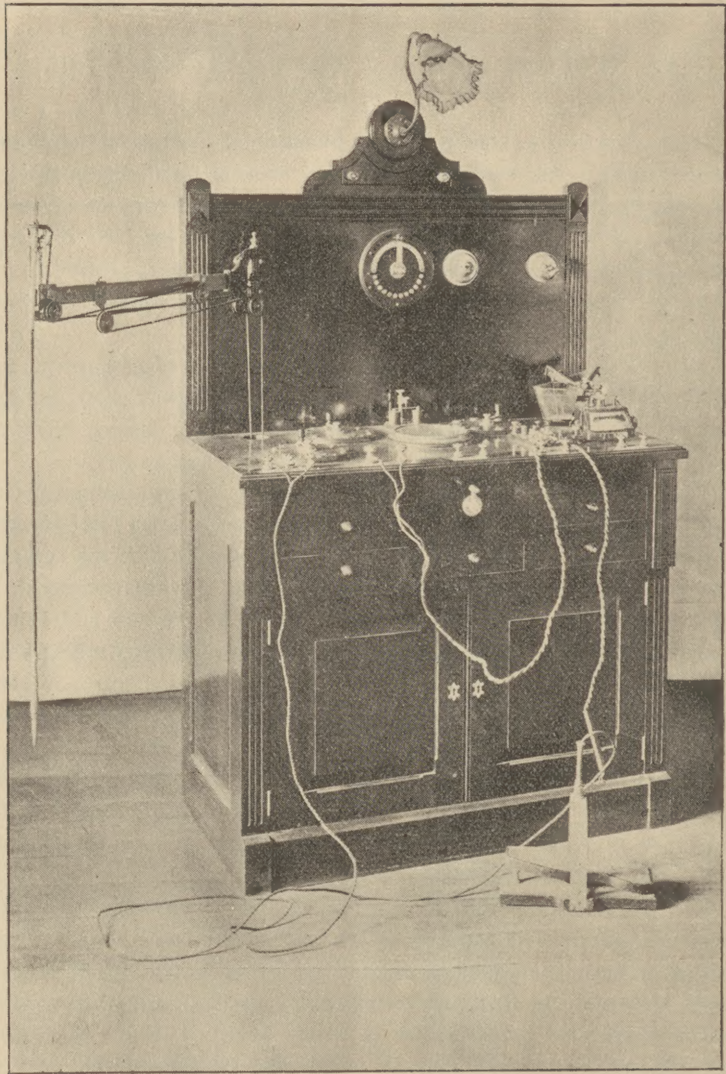

Fig. 1.

Complete External View (Photographic) of the Cabinet

means of an automatic brake, the drill may be instantly started or stopped, within the one-tenth part of a second, at the will of the operator, by a simple movement of the footpiece.

The current for lighting up miniature lamps, such as Voltolini's Trouve's, Vohsen's or Heryng's lamp, etc., is controlled by a rheostat in shunt, so that lamps of either high or low resistance may be used. By connecting wires with the binding-posts of the cabinet, the current may be conveyed to a specially designed "dark room," where it may be controlled by a simple switch. This method I have adopted in my office, and find very convenient in the examination, by trans-illumination, for diseases of the maxillary sinuses.

The induced currents which may be obtained from the cabinet are six in number: The primary *(induced)*, the secondary, the combined primary and secondary, the alternating primary, the alternating secondary, the combined primary and secondary alternating. Any one of these currents may be obtained by a movement of the lever of the current-selector *E* (Fig. 2), the strength of the current being regulated by means of the lever *R*, in connection with the indicator. The variety of these currents and their range of strength allow a wide latitude for their adaptability in electrotherapy.

The galvanic current supplied by the cabinet contains in its circuit a water-rheostat, milliampere meter and polarity-changer. By means of a special device, the current supplied is protected from the dangerous influence of currents of high potentiality from outside wires, which may accidentally fall across the wires which furnish the current to the cabinet. This device also allows of delicate adjustment of the current, so that a strength of from one-tenth of a milliampere to 500 milliamperes may be used.

The important mechanism of the cabinet is a motor-dynamo, upon the action of which much of the capacity of the cabinet depends. As the name implies, the motor-dynamo is both a motor and a dynamo. Its special function is to transform an available existing condition of direct electrical pressure and volume into another ratio of pressure and volume which may be required for special work.

This motor-dynamo was adopted for several reasons, prominent among which that of obtaining currents of low potential, free from the dangers and cost of using a 110-volt current from the Edison mains direct.

There is a great loss of energy to use a current having a potential of 110 volts in cautery work, when a 5-volt current will do the work, the ratio being 5 to 110; that is, we are wasting 105-110 of the total energy passing through the circuit, and utilizing only 5-110 in the heating effects upon the cautery.

The manner in which we economize energy by means of the dynamo-motor is very simple. By its agency we take, for instance, a current of 2 amperes at 110 volts pressure, equal to 220 Watts, and transform it into mechanical energy (loss about 10 per cent. during conversion), or rotary motion similar to that of any ordinary motor, which motion, being transmitted to a shaft carrying another armature of similar construction, but wound differently, enables us to obtain a corresponding reduction in electrical pressure, and an increase in the volume of current flowing, in direct proportion to the decrease of this pressure.

On this principle, if we take a current of 2 amperes at 110 volts, equal to 220 Watts, and reduce this to 5 volts by conversion, we obtain 44 amperes of current at 5 volts, which is also equal to 220 Watts, with no greater expenditure of mechanical energy than is represented in the first case, except such losses caused by friction in the parts, self-induction and eddy currents, which do not exceed 10 per cent. for each conversion, making a total loss of 20 per cent for the whole ap aratus.

Although in the construction of the motor-dynamo two independent armatures, 110 volts and 5 volts respectively, are used, yet there is but one pair of field magnets, which envelops both armatures at the same time, which is a saving in the first cost of the apparatus, and likewise economizes the amount of current required to excite them.

The side marked *A* (Fig. 3) represents that part of the field magnet covering the motor armature, and to the right of this is the commutator by which the Edison current at 110 volts pressure is admitted. This causes the motor to revolve, and thus gives the shaft a definite rate of speed. The dynamo armature being attached to this shaft is caused to rotate at the same rate of speed as the motor armature, and also in a field always of the same strength. The dynamo armature, by its rotary speed and power, generates a current of low pressure and great quantity, such as is necessary for cautery work, and this current is delivered to the commutators B^1, B^2 and B^3, the first two being alternating currents and the last a continuous, all having the same potential.

B^3, therefore, gives a continuous current that is available for operating the induction coil with the interrupter in circuit; and from the commutators B^1 and B^2 we draw an alternating current which is here used to heat the electro-cauteries, and also to operate the induction coil without the use of the interrupter.

It has hitherto been the practice of different makers when constructing dynamos of low tension currents to generate and make use of those currents flowing in one specific direction called *continuous;* but, in this apparatus, this process is reversed—a current which alternates about 6000 times per minute being used. This current, on account of the rapid change of polarity, secures a longer life to the electro-cauteries than when they are heated by a continuous current.

It is a well known fact that the side of any incandescent conductor, through which the positive enters, will waste away more rapidly than the negative side, and for this reason it is desirable to equalize this action in using the electro-cauteries.

The principal reason, however, for employing the alternating current in this connection is that it enables us to use a commutator having no openings or divisions in its periphery, thereby excluding the possibility of sparking, a point of great importance, as it concerns the life and correct working of one of the vital parts of the apparatus.

Sparking is one of the great causes of cutting and destructive wearing of motor and dynamo commutators. For this reason carbon brushes are used throughout the apparatus, to the entire exclusion of copper, experience having taught that nothing can equal carbon for this purpose, in the present state of our knowledge.

The objection to copper brushes lies in the fact that both the commutator and the brushes being metallic, the current (especially such a heavy current) has a tendency to fuse their surfaces together; as the continued rotation will not permit this, particles are torn off continually, causing what is known as "cutting," which, in some cases, may become so great as to wear out a new commutator in a few hours. Carbon, being non-metallic, can not be fused to the rotating commutator, hence its superiority for this purpose. There are fourteen brushes used in this apparatus, and, were they of copper, there would always be difficulty in getting the machine to work smoothly and successfully.

The motor-dynamo of this cabinet is capable of furnishing mechanical energy to the extent of one-quarter horse-power.

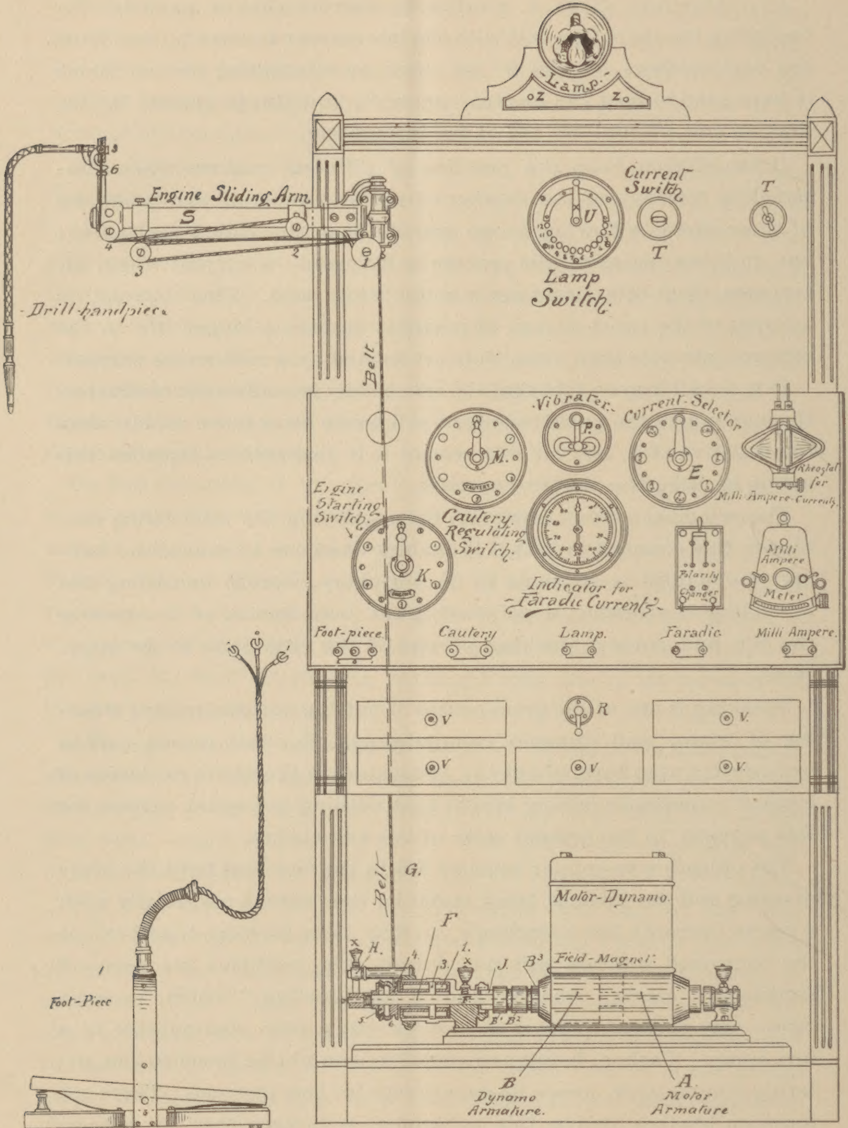

Fig. 2.

Schematic View of the Whole Apparatus.

At the end of the shaft *F* (Fig. 3) there is a small apparatus called an "automatic brake," the object of which is to start and stop the power from the motor-dynamo to the belt *G*, which operates the drill engine, at the will of the operator, and controlled by what is called a "footpiece."

The automatic brake consists of five essential parts, marked respectively, *1*, *2*, *3*, *4*, *5* (Fig. 3), of which *1* and *2* are electro-magnets, *3* a keeper actuated by them, *4*, a sleeve carrying a pulley at one end and the keeper *3* at the other and free to move longitudinally on the shaft *F* within a limited scope; *5* is a friction cone fastened permanently to the shaft *F*, and, therefore, rotating with it. *H* is an outboard bearing made of hardened and accurately ground tool steel, and is put there for the purpose of steadying the shaft *F* and to prevent undue side strain from the action of the belt *G*. *J* is a hardened and ground steel collar and washer which receives the thrust due to the pressure of the brake magnet *(2)*.

On examining the top board of the apparatus (Fig. 2) there will be seen a set of three binding-posts called *footpiece*, and marked *2*, *0*, *1*. They serve for the double purpose of actuating the brake by means of the footpiece and controlling the cautery current, both being operated with the same footpiece.

In this connection the *current selector* is used. This has eight contacts, marked, respectively, *Engine*, *Cautery*, *Interrupted Primary*, *Interrupted Secondary*, *Interrupted Primary and Secondary*, *Alternating Primary*, *Alternating Secondary*, *Alternating Primary and Secondary*. The connections are so made that when the handle of the current selector is placed over the word *engine*, the cautery and induction coil currents will be automatically cut out, and can not be used while the engine is in operation. This provision is necessary, because the engine may be run at a variable speed by means of the switch *K*, but these variations would seriously hamper the use of the cauteries and induction coil.

To illustrate this, suppose two operators desired to use the engine and cautery at the same time, and let us suppose that the apparatus were so constructed as to permit of such use. If, then, the operator using the engine adjusted the engine at the lowest speed, and the other operater at the same time employed a small cautery which he brings to the proper degee of heat by means of the switch *M*. If, now, the first operator, desiring to increase the capacity of his drill, increases the speed of his engine by moving the lever at *K*,

the dynamo will simultaneously increase the strength of the current supplied to the electro-cautery, which would probably be at once burnt out.

When the apparatus is used for cautery purposes it is requisite that the starting switch *K* should be at full power in contact *5*, and the current selector must be on contact marked *cautery*, and, when in this position, the footpiece attached to the binding posts *2*, *0*, *1* will be cut out from operating the brake and engine belt *G*, but will simply put the current on or off the cauteries attached to the cautery binding-posts. A forward motion of the foot will turn on the current and a backward motion will cut it off.

The action of the footpiece is the same when the selector handle is in contact marked *Engine*, but, instead of operating the cautery, it clutches in or out the brake pulley on shaft *F*, causing the cable, with its drill, to rotate or stop instantaneously, according to the will of the operator.

In the *automatic brake*, this is accomplished by means of the magnets *1* and *2* (Fig. 3). When the current is turned on the magnet *1*, it is at the same instant cut off from magnet *2*, the result being that the sleeve carrying the pulley *6* is attracted toward magnet *1*, and pressed firmly against its surface with a tension of about 50 pounds. When the footpiece is pressed forward the current is cut off from magnet *1* and is transferred to that of *2*. This causes the sleeve to press forward, but this time it does not reach the face of the magnet *2*, being arrested by the pulley *6* coming in contact with the friction cone *5* fastened to the shaft *F*. This at once causes the pulley to acquire the speed of the shaft, to be again checked when the footpiece is depressed backward, and the keeper *3* is brought in contact with the face of magnet *1*. The binding-post *0* is common to both magnets *1* and *2*, and therefore there are but three wires in the footpiece.

The current which operates the electro-cauteries does not pass through the footpiece, as this extra resistance would be important to a current having a potential of only five volts. Instead of this the constant current from the dynamo is passed to the footpiece, which operates a *magnetic circuit closer*, through which the alternating current which heats the cauteries is passed. When the footpiece is depressed forward the constant current passes to the electro-magnet of the circuit closer, and the switch is drawn down, allowing the alternating current to pass to the cautery. When the footpiece is

depressed backward the switch of the circuit closer is released, and the alternating current no longer passes to the cautery.

The footpiece thus serves a double purpose—that of controlling the engine and the cautery—and either one may be used according to the position of the current selector *E* (Fig. 2). The cautery can, however, be used at the same as any of the induction coil currents, and the cautery may still be used when the selector handle is over any of these contacts. The only time that the cautery can not be used is when the engine is used, for the reason already explained.

When the motor-dynamo is used to operate the engine, it may be used at any speed within the limits of the rheostat *K*, but when it is used to operate the cautery or induction currents it should be used

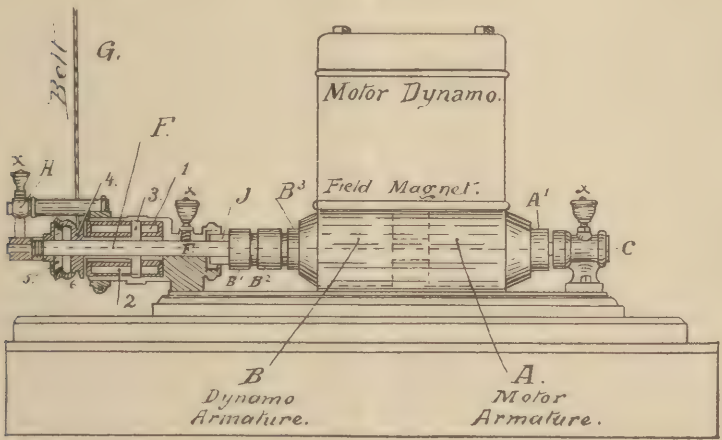

Fig. 3.

Part Section View of Motor-Dynamo and Brake.

at full speed, the lever of the rheostat *K* being on the point 5. The cautery currents are taken from the binding-posts marked *Cautery* on the top board of the apparatus, and the faradic cúrrents from the binding-posts marked *Faradic*.

There are six forms of faradic currents generated in this apparatus, all of which are available from the same pair of binding-posts, thus avoiding the inconvenience of selecting a new pair of binding-posts each time that a different current is required. The current that the operator desires to use is carried to the binding-post by means of the lever of the *current selector E*, which is placed over the contact marked *Primary*, *Secondary*, etc.

The *Indicator for Faradic Currents* (Fig. 2) is operated by the small handle *R* in front of the apparatus, and its object is to indicate the relative immersion of the primary into the secondary coils of the induction coil proper, which is made up of a number of coils so as to permit of the use of simple and complex currents. This indicator serves for all six currents, and by means of the handle *R* the strength of the current can be very accurately graded to suit the requirements of the case. Although the scale is an arbitrary one, still it enables the operator to keep a record of the number of degrees required to give the best results to the patient, and enabling him to use the same strength that was found efficient on a former occasion. *P* is the rheotome, and is so arranged that it can be adjusted to coarse or fine vibrations by turning the screw of the contact point.

X X are oil cups on the motor-dynamo, which require filling regularly. The commutators should be kept clean and a little vaseline rubbed on the wearing surfaces as a partial lubricant and to deaden the vibrations of the brushes. The motor-dynamo is held down to the bottom of the cabinet by its own weight only, and it rests on six gum washers, so as to prevent undue vibrations of the floor and surroundings.

The belt *G* after leaving the pulley of the motor-dynamo travels upward and passes over the pulleys marked *1*, *2*, *3*, *4*, *5*, the pulley *5* being the one attached to the regular S. S. White engine cable and hand piece, the general design of which is shown in the plan (Fig. 2). The pulleys *2* and *3* are attached to the sliding arm and serve the double purpose of taking up the slack of the belt when the arm is slid in or out, thus preserving at all times the same degree of tension on the engine belt *G*.

The engine arm *S* is capable of turning on a centre from side to side, and the centre of motion is so adapted that the belt is always in its radius, and thus never suffers any distortion or strain and can not fall off unless it is loose. Whenever the belt is too loose for proper work the small sliding head to which pulley *4* is attached may be moved forward until the belt has the proper degree of tension.

The engine cable head marked *6* can also be rotated on a common centre to the extent of half of an arc of a circle. The cable itself has all the movements commonly given to these devices by the S. S. White Dental Co.

v, *v*, *v*, *v*, *v* are drawers for instruments, electrodes, flexible cords, etc. *T* is a *quick-break* switch, which cuts off all the currents from

the apparatus when not in use. The engine switch *K* is also fitted with a quick-breaking attachment, so that as the lever leaves the last contact the circuit is broken with a quick snap, thus preventing the possibility of arcing and its consequent injury to the woodwork and the metallic contacts forming part of the circuit.

The miniature lamp switch *U* (Fig. 2) receives its current directly from the Edison mains, and is not dependent upon the motor-dynamo for its energy, and the current from this is conveyed to the binding-posts marked *Lamp*. This lamp circuit is so a ranged that the current is drawn from the Edison mains in *shunt*, and not in *series*, as is usually done. For this purpose, the current from the Edison mains is passed through wire resistance of great length and fastened in coils to the back part of the cabinet. By tapping this wire at different points of the circuit, by means of the lamp switch *U* (Fig. 2), we obtain a current of sufficient intensity to produce incandescence in the miniature lamp connected with the binding-posts marked "tramps" (Fig. 2).

By means of this shunt system, we avoid the sparking incident to using the current when the lamps are placed in series.

Z, *Z* are the binding-posts to which are attached the wires leading to the Edison mains. The action and details of the footpiece used in this apparatus are shown in the Plan, Figure 2, and require no extended description here. T^1 is the main switch of the galvanic current.

As the tension of the Edison current (110 volts) is too high to make it convenient for the delicate adjustments required for galvanism, and as, moreover, the direct current is not free from a certain element of danger, such as the crossing of the wires with an outside wire carrying a current of high and dangerous potential, I have introduced into the cabinet an arrangement devised by my assistant, Dr. Scheppegrell.* In this arrangement, the direct current is passed through a number of lamps, which divide up the difference of potential, and, by means of a volt-selector, a shunt current is taken from the lamp circuit, varying in strength according to the position of the volt-selector. If, for instance, the current be passed through four lamps of equal resistance, the tension of the current will be divided into four equal parts, and, by adjusting the lever of the volt-selector, we may make use of a current of 27½, 55, 82½ or 110 volts respectively, thus allowing of more accurate adjustment of the

*New Orleans Medical and Surgical Journal, January, 1893.

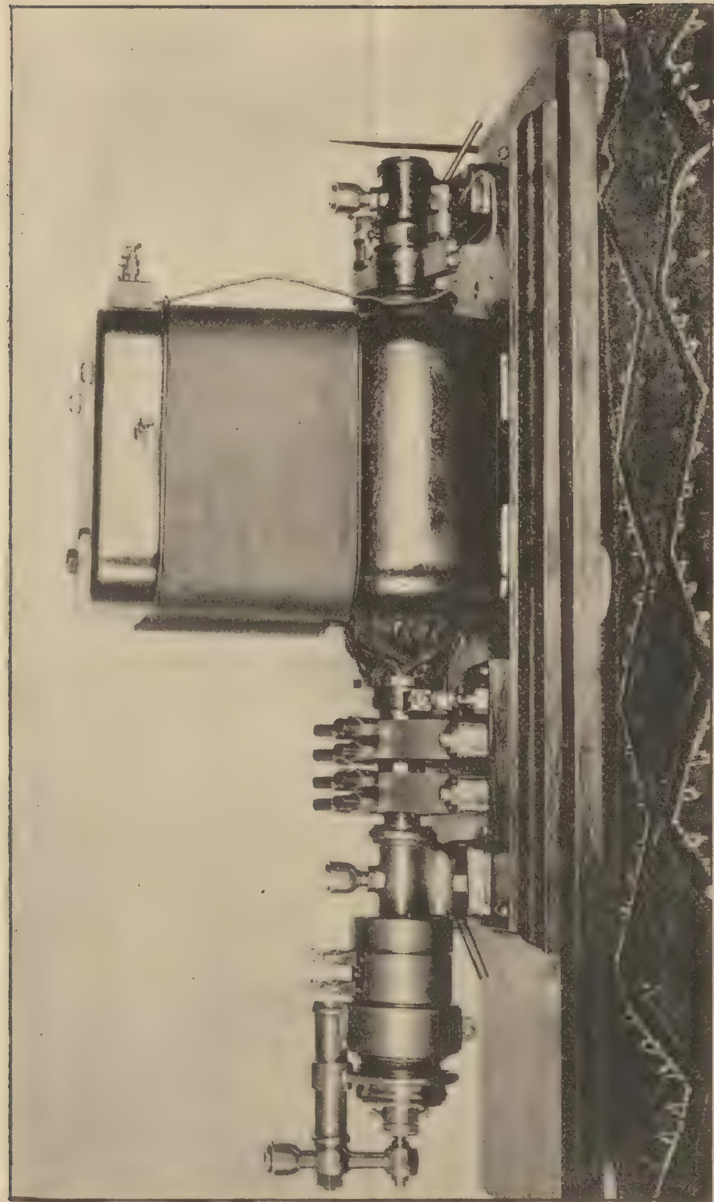

Fig. 4.
View of Motor Dynamo (Photographic).

current. As there will be less resistance through the lamps than through the water rheostat and patient, this shunt arrangement forms a safeguard to the patient from extraneous currents.

The current, after being adjusted by the volt-selector, is regulated by means of a New Bailey rheostat, the strength of the current being shown by the milliampere meter. A polarity-changer is used for reversing the polarity of the electrodes.

In regard to using the motor-dynamo for heating the electro-cauteries, it has not only the advantage of convenience and economy over using the Edison current direct, but also the important item of safety. Let us suppose a case where the surgeon has a patient in his chair and is operating on any part of the body with a cautery electrode carrying a 110 volt current, and while doing so a wire in the street carrying a current of from 500 to 2000 volts should become accidentally detached and fall npon the lines leading to the office. This would injure the patient severely, and is an accident that happens quite frequently to all electric light circuits, the central station dynamos being sometimes burnt out from this cause.

Outside of the dangers common to electric light circuits in general, the use of the Edison 110 volt current is individually dangerous for electro-cautery work, because should the point of the platina electrode break or become fused while in use on a patient, and while carrying a heavy current equal to twenty amperes or more, it would, under such a potential, form a very heavy arc similar to the street lights, and, by the intense heat generated, cause considerable destruction of tissue before the operator could have time to withdraw the electrode, which contingency might, under some circumstances, ruin the patient for life. Such a contingency is impossible with a potential of only five volts, due to the fact that an arc can not be maintained between any two points at a lower potential than twenty volts with sufficient intensity to do any damage or produce uncomfortable results.

By the use of the motor-dynamo system the patient is not brought into contact with the Edison circuit direct, and should any outside wire fall on the wires as described above, it can only result in blowing out the fusible plugs by which the motor-dynamo is protected from heavy currents.

Another element of danger to be considered lies in the use of a current of such a high potential as 110 volts for cautery work, outside of any consideration of the question of cost. Suppose you have an

electrode in the circuit that requires a current of twenty-two amperes; this will, at a pressure of 110 volts, consume an energy of over three horse-power. Now should the cautery suddenly break, from any cause, while it is being used, there will be formed a heavy *arc*, which would destroy all tissue within one-quarter radius of the arc so formed.

A current of twenty-two amperes at five volts, such as is supplied by the motor-dynamo, could not give rise to an arc that would in any way be dangerous to the patient.

The engine can be operated at from 1500 to 6000 revolutions per minute, is adapted for using all kinds of drills and other attachments, and can be stopped within the one-tenth part of a second while making 6000 revolutions per minute.*

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*At the present date this apparatus has been in constant use for two years, and during that time has given me entire satisfaction without necessitating any repairs or skilled attention.